

## SEASONAL FEEDING HABITS OF AN ENCLOSED HIGH DENSITY WHITE-TAILED DEER HERD IN NORTHERN OHIO<sup>1</sup>

JACK ROSE<sup>2</sup> and JOHN D. HARDER, Department of Zoology, The Ohio State University, Columbus, OH 43210

**ABSTRACT.** Seasonal feeding habits of the white-tailed deer (*Odocoileus virginianus*) herd on the National Aeronautics and Space Administration (NASA) Plum Brook Station, near Sandusky, Ohio, were determined by microscopic analysis of rumen contents. At the time of this study,  $2,499 \pm 94$  (95% C.I.) deer inhabited the area, a density of 115 deer/km<sup>2</sup>. Deer grazed year-round, and in spite of a record high density, overall health of the herd was high. During a winter with deep snow cover, grass consumption decreased almost 50% when compared with the previous winter with light snow cover. Consumption of dead deciduous leaves approximately doubled during the same period. Neither snow depth nor inclement weather had any observable effect on the amount of woody browse in the diets; consumption of this food remained low during all seasons.

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### INTRODUCTION

White-tailed deer (*Odocoileus virginianus*) feed on a wide variety of plants. An extensive study by Korschgen et al. (1980) revealed 458 plant foods in the spring and summer diets of deer in Missouri. Many reports have emphasized the importance of woody browse, shrubs and small trees, particularly on northern winter ranges (Aldous and Smith 1938, Hosley 1956, Martinka 1968, Coblenz 1970, Telfer 1972). However, depending on geographical location and season, some deer populations have been found to graze considerably throughout much of the year (McCafferty et al. 1974, Coblenz 1970, Nixon et al. 1970).

Accurate information on seasonal feeding habits of deer is essential for proper range appraisal and management. Estimates of carrying capacity based on the assumption that deer depend on woody browse for two to four months of the year would be substantially lower than those made for deer that graze during most or all of the year. The high energy requirements

of white-tailed deer necessitate a high turnover of readily fermented foods within the rumen (Short 1963). A diet of woody browse, having a higher lignin to cellulose ratio, would be less digestible and not yield as much energy as a diet of more easily digested grasses and forbs (Cook and Harris 1950, Short et al. 1972, Short 1975).

In the mid 1970s we became interested in the possible role of grazing in the apparent high carrying capacity of NASA's Plum Brook Station in northern Ohio. A helicopter-assisted, mark-recapture study of the herd documented the presence of  $2,499 \pm 94$  (95% C.I.) deer on the station, a density of 115 deer/km<sup>2</sup>, the highest ever reported for the white-tailed deer (Rice and Harder 1977). Despite this high density, deer were in good condition. Body weights for mature (2-1/2 yr or older) does during the winter averaged  $55.6 \pm 3.0$  kg, (Rose 1978) and, although somewhat depressed, were well within the normal range for this species. Necropsy of 620 deer collected in all seasons revealed abundant fat reserves and no evidence of disease or malnutrition. No winter die-offs were observed, and annual adult mortality was estimated at less than 10% (Harder 1980).

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<sup>2</sup>Present Address: Department of Animal Science, Oregon State University, Corvallis, OR 97331

The purpose of this study was to document the seasonal feeding habits of the record high density deer herd on Plum Brook Station. We were also able to compare the feeding habits of deer during two winters that differed markedly in temperature and snow accumulation.

### STUDY AREA

The study was conducted on NASA's Plum Brook Station, near Sandusky in north central Ohio. The 2,176-ha station was completely enclosed by a 2.44-m chain link fence with barbed wire overhang. Roads, buildings and parking lots occupied four percent of the station (Palmer et al. 1980), the balance was covered by natural vegetation. Water was available in drainage ditches, ponds and swamps throughout the year.

Eleven percent of the station was covered by well-stocked (>70%) woodlots (fig. 1), containing large trees (10.2-27.7 cm diameter breast high or larger), which contributed little to available browse. The term "stocking," as used here, is synonymous with crown closure for woody species, and with the degree of vegetative ground cover for herbaceous species.

Woodlots on poorly drained sites were composed of pin oak (*Quercus palustris*), swamp white oak (*Q. bicolor*), common cottonwood (*Populus deltoides*), and black cherry (*Prunus serotina*). Pignut (*Carya glabra*), and shagbark (*C. ovata*) hickories, white oak (*Q. alba*), green ash (*Fraxinus pennsylvanica*), beech (*Fagus grandifolia*) and sycamore (*Platanus occidentalis*) grew on the drier sites. Approximately 37% of the station was covered by a canopy-dogwood association, similar in composition to the woodlots, but only medium to well stocked (40-69%) and with shrubby dogwoods (*Cornus* spp.) in the understory.

Nearly one-half of the station was covered by grasslands of the following plant associations: grass-forb, wooded-grassland, and dogwood-grassland. The grass-forb association covered 31% of the station and was maintained in an active

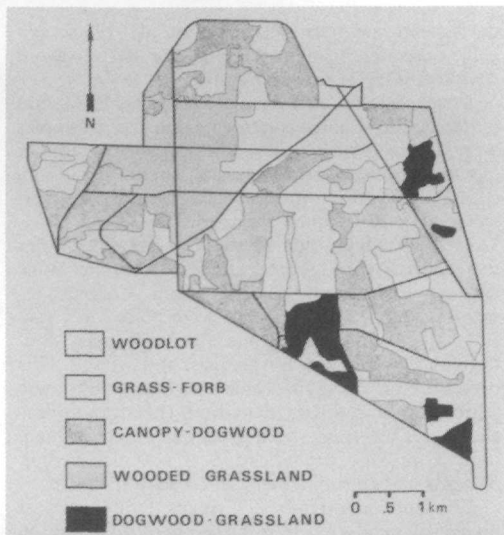


FIGURE 1. Cover map of Plum Brook Station, Ohio. The grass-forb association covered 31% of the station; dogwood-grassland, two percent; wooded-grassland, 15%; canopy-dogwood, 37%; woodlots, 11%; and roads and buildings, four percent. This map was redrawn from a detailed cover map constructed by P. Busch and D. Haugen, U.S. Fish and Wildlife Service, July 1975.

growing stage through annual mowing and burning. Some of the major species were: avens (*Geum canadense*), clovers (*Trifolium* spp.), false foxglove (*Gerardia* spp.), plantains (*Plantago* spp.), orchard grass (*Dactylis glomerata*), meadow fescue (*Festuca pratensis*), bluegrass (*Poa* spp.), redtop (*Agrostis stolonifera*) and quackgrass (*Agropyron repens*). Wooded grasslands covered 15% of the station and were similar to the grass-forb association except they were poorly stocked (10-39%) with scattered clumps of trees. The remaining two percent of the station was covered by dogwood-grasslands consisting of well-stocked dogwood and the grass-forb association previously described. Dogwoods in this association were generally less than 1.5 m high and were heavily browsed.

### METHODS AND MATERIALS

Samples of rumen contents from 130 adult female deer (2-1/2 yrs or older) were obtained during public hunts and special collections held monthly from December 1975 through March 1977. These collections were part of an effort to reduce the high deer

density on the station (Palmer et al. 1980). No collections were made in May or June 1976 to avoid the possibility of orphaning fawns.

Intact carcasses were necropsied within 15-60 min of death. Physical measurements and tissue samples were collected for related studies. One-liter samples of rumen contents were removed, squeezed through cheese cloth, frozen in plastic bags on dry ice, and stored at  $-10^{\circ}\text{C}$  until analyzed.

After thawing, each of the 130 rumen samples was washed through three sieves with openings ranging in size from 9.5 to 1.0 mm. Contents remaining in the 9.5-mm sieve were placed in a tray and ocular estimates were made of the percentages of forbs and grasses, tree leaves, mast and browse. This procedure provided an estimate of mast and browse which could not be identified through microanalysis. Data from these gross examinations were used to provide an indication of seasonal feeding patterns and to supplement microanalysis.

The contents from all sieves from each of 86 samples collected from December 1975 through November 1976 were combined and processed for microanalysis similar to the techniques of Sparks and Malechek (1968) and Ward (1970). Each sample was dried and ground through a Wiley mill over a one-mm sieve. Five microscope slides were prepared for each sample so that three to five particles could be seen in each field of view at 100 magnifications (Todd and Hansen 1973). For each slide, 20 fields of vision were located systematically, giving 100 fields per sample. In each field of vision all fragments with a visible epidermal pattern were identified and recorded.

Identification of plant fragments was made using reference slides and photomicrographs of vegetation samples from Plum Brook Station, with the aid of descriptions from the following publications: Martin (1955), Davies (1959), Metcalfe and Chalk (1950), Metcalfe (1960, 1971), Dunn et al. (1965), and Rajagopal and Ramayya (1977), and others cited in Rose (1978). Plant nomenclature is according to Weishaupt (1971). Those fragments not identifiable to genus or species were recorded as "others" in the subclass monocotyledonae (monocot) or dicotyledonae (dicot). The composition of each sample was expressed on a percentage basis by taking the total number of times a particular plant taxon was identified, dividing it by the total number of fragments identified in the sample and multiplying it by 100.

## RESULTS AND DISCUSSION

**SEASONAL FEEDING HABITS.** Ocular estimates of the major forage classes in rumen contents revealed heavy grass and forb consumption throughout the year (fig. 2). Woody browse was consumed only in winter and in small amounts. Mast was important only in September 1976 when it represented over 50% of the diet.

## SEASONAL DEER FOODS

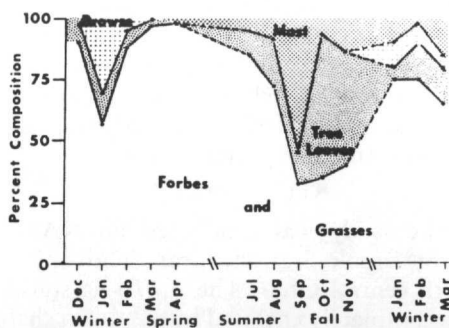


FIGURE 2. Diet composition of mature (2 yr or older) female white-tailed deer collected on Plum Brook Station, Ohio, from December 1975 through March 1977, as determined by ocular estimation ( $N = 10$  deer per month).

Microscopic analysis of rumen contents revealed 40 different plant genera in the diets of deer (Rose 1978). Undoubtedly numerous other species were eaten but not identified. Nixon et al. (1970) found 160 species of plants in the stomachs of white-tailed deer collected in Ohio over a 3-1/2 yr period. However, only 43 species occurred in more than one percent of their samples, and these made up 95.6% of the total weight of foods ingested. In the present study, nine genera each comprised more than three percent of the average diet during at least one season, but only four of these (meadow fescue, quack grass, dogwood, and avens) made up more than three percent of the diets in all seasons (table 1).

Monocots constituted 66% of the winter diet of deer, while dicots comprised only 34% (table 1). Grasses, especially meadow fescue, represented the most important monocot, and dogwood leaves represented the most important dicot. Diets were similar during winter and spring, but consumption of monocots, particularly *Carex* spp., increased slightly in spring.

Monocots declined from 70% of the diet in spring to 15% in the summer when a larger variety and quantity of dicots were eaten. Clover, wild strawberry, goldenrod and avens comprised 24% of the summer dicot diet compared to 13% in the spring (table 1). Forbs such as goldenrod mature much later in the season than do many

TABLE I

*The average percent composition of the diet of mature (2 yr or older) female white-tailed deer collected on Plum Brook Station, Ohio, from December 1975 through November 1976 as determined by microscopic analysis of rumen contents. The number of samples in which a given species occurred is given in parentheses. Plant fragments comprising less than three percent of the diet are listed as trace (tr); unidentifiable fragments are listed as "others."*

Food Item	Winter (Dec-Feb) N = 30	Spring (Mar-April) N = 20	Summer (July-Aug) N = 19	Fall (Sept-Nov) N = 17
<b>Monocots</b>				
Meadow fescue	17(30)	17(20)	4(18)	11(16)
Orchard grass	9(27)	10(19)	—	tr(11)
Quack grass	9(27)	6(19)	3(12)	6(16)
Sedge	3(22)	10(16)	—	—
Others	28	27	8	16
Subtotals	66	70	15	33
<b>Dicots</b>				
Dogwood	10(29)	4(13)	3(19)	9(16)
Clover	tr(3)	4(2)	9(17)	tr(2)
Wild Strawberry	tr(3)	4(9)	5(10)	3(7)
Goldenrod	tr(3)	tr(3)	5(12)	7(4)
Avens	3(14)	5(10)	5(10)	7(11)
Others	21	13	30	41
Subtotals	34	30	85	67

grasses (Martin et al. 1951). Furthermore, as grasses mature and form seeds, nutritional quality declines. In western North Dakota both native and tame grasses lost an average of 71% of their protein by 30 September (Whitman et al. 1951). As the nutritional value of grasses declined on Plum Brook Station in late summer, a great variety of forbs were apparently consumed to satisfy energy requirements.

The summer diet was eight times higher in the percent composition of dogwood leaves than in spring. Perhaps the ripening of dogwood fruits in late summer (Martin et al. 1951), made this species a more attractive food source. Alternatively, seasonal changes in the chemical composition of leaves might have been responsible for this increased utilization.

During the fall, deer again relied on grasses for a major portion of their diet while dogwood consumption decreased to nine percent of the diet. Reduced consumption of dogwood was probably related to the plants dormant state with leaves drying out and becoming less palatable.

The largest category for the fall season was dicots, many of which were unidentified. Forbs continued to represent a major food item. Goldenrod for example represented 20% of the diet during the month of September (Rose 1978).

**SNOW DEPTH AND BROWSE UTILIZATION.** We were fortunate to obtain rumen samples during both the mild winter of 1975-76 (N = 20) with only 13 days when more than 7.6 cm of snow covered the ground, and the severe winter of 1976-77 (N = 8) when snow accumulation exceeded 7.6 cm for 43 days and 30.5 cm for 27 days. This enabled us to compare the relative importance of browsing and grazing under mild and severe winter conditions. Diet comparisons were made by averaging samples from January and February of each year. The percent composition for each species determined by microscopic analysis was adjusted down by a percentage equal to the amount of woody browse estimated during the gross examination (fig. 2). Because woody browse was not identified by microscopic analysis,

we felt this manipulation would provide a more realistic estimate of the winter diet composition.

Consumption of woody browse was not affected by snow accumulation. During both the mild winter of 1975-76 and the severe winter of 1976-77, browse remained a relatively unimportant component of the diet, 18% and 14%, respectively (fig. 2). Monocots declined from 54% of the diet during the winter of 1976 to 29% during the winter of 1977, while dicots increased from 28 to 57%. Most of the increase in dicot consumption was attributed to dead leaves from oak, cherry and other unidentified dicots. A reduction of grasses in the diet and an increase in tree leaves typical of the canopy-dogwood association suggested that the deep snows and severe weather prevented deer from grazing and forced them to seek cover in woodlots. Even though dead tree leaves would have been lower in nutritional value than forbs and grasses (Short et al. 1972), it might have been energetically advantageous for deer to forage in the shelter of wooded areas rather than seek herbaceous plants out on the exposed, windswept grasslands. On the George Reserve in Michigan, herbaceous plants completely disappeared from the diet of deer foraging on ground covered by more than 7.6 cm of snow (Coblentz 1970).

**METHODOLOGICAL CONSIDERATIONS.** Some caution should be used in judging the relative importance of various plant species in the diet of deer due to inherent technical difficulties of microanalysis (Westoby et al. 1976, Dearden et al. 1975). Plants easily identified by epidermal characteristics such as dogwood and sedges were probably overestimated while others, more difficult to identify, contributed to the group "others" that could not be identified further than monocot or dicot, which on an annual basis averaged 33% of the recorded fragments. It is possible that some of these unidentified plants were very important deer foods. Bluegrass, for example, was a common grass on the

station, yet was detected in only trace amounts in the diet.

Seeds have no epidermal pattern and as such, could not be identified microscopically. Eleven deer collected in the fall of 1976 consumed such larger quantities of mast (fig. 2) that grinding and microanalysis were impractical. These samples were analyzed by the point frame technique of Chamrad and Box (1964). Fifty-one percent of the diet was composed of seeds with oak and cherry being the most abundant; tree, grass, and forb leaves made up the remainder.

Because of such technical difficulties, it is suggested that future feeding habits studies combine one or more macroscopic techniques (point-frame, dry weight estimates, etc.) with microscopic analysis to provide as complete a description as possible of diet composition.

### CONCLUSION

This study documented year-round grazing by deer on Plum Brook Station. Monocotyledonous plants, most of which were grasses, comprised 46% of the average annual diet (table 1). Most of the dicotyledonous plants eaten were forbs and subject to grazing. Woody browse was not an important food for deer on Plum Brook Station even during periods of deep snow cover and low temperatures. Forage availability appeared to play the dominant role in determining the foods selected by deer, as approximately 50% of the station was covered by grass and forbs (fig. 1). We hypothesize that the habitat conditions leading to year-round grazing was the major contributor to the high carrying capacity of the station. By designing management practices which favor the forage plants identified in this study, it should be possible to establish environments elsewhere that would provide nutritional support for deer at much higher densities than are currently achieved.

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